

Laser wavelengths and oral implantology

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Received: 1 February 2009 / Accepted: 10 April 2009 / Published online: 9 May 2009
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Abstract In modern implant dentistry there are several clinical indications for laser surgery. Different laser systems have a considerable spectrum of application in soft and hard peri-implant tissues. The literature was searched for clinical application of different laser wavelengths in peri-implant tissues: second-stage surgery of submerged implants, treatment of infrabony defects, removal of peri-implant hyperplastic overgrowths, and, possibly, the preparation of bone cavities for implant placement. This report describes the state-of-the-art application of different laser systems in

modern implant dentistry for the treatment of peri-implant lesions and decontamination of implant surfaces. Our study evaluated *in vitro* examinations, clinical experience and long-term clinical studies. The exact selection of the appropriate laser system and wavelength was dependent on the scientific evaluation of recent literature and the level of changes in implant and tissue temperatures during laser application. The significant reduction in bacteria on the implant surface and the peri-implant tissues during irradiation and the cutting effects associated with the coagulation properties of the lasers are the main reasons for laser application in the treatment of peri-implant lesions and the successful long-term prognosis of failing oral implants. The various applications of lasers in implant dentistry are dependent on the wavelength and laser–tissue interactions.

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Keywords Implants · Lasers

Although a large number of endosseous implants are being placed and do have a high survival rate [1], the significant annual increase in implant placement is associated with several complications. These are reversible pathological reactions of the peri-implant soft tissues, ‘mucositis’, and ‘peri-implantitis’, progressive destruction of bone around the implant after osseointegration. These reactions are caused by advanced inflammatory changes in the surrounding tissues, so that abnormalities in the tissue around the implant may be the main reason for implant failures. Over a 5-year period, 0–14.4% of dental implants demonstrated peri-implant inflammatory reactions associated with crestal bone loss [2]. Bone complications around the implant may lead to implant failure if no treatment can be established.

Bacterial aggregation begins in the soft tissue around the implant neck, and the bacteria may penetrate the implant–abutment connection. The inflammation spreads apically

and causes vertical and horizontal bone loss. This bacterial infection around the implant is considered to be similar to periodontal disease [3–7], presenting similar microbiological characteristics. Specifically, putative, periodontal pathogens have been detected [8], and *Porphyromonas gingivalis* is found in very high proportions [9–11].

Non-surgical methods of peri-implantitis treatment include mechanical instrumentation and the use of a variety of antibacterial agents. The use of different antimicrobial agents is possible but is only effective when applied during the early stages of the disease [12–14]. Subgingival irrigation with local disinfectants, and local antibiotic therapy with tetracycline fibres, were employed, but neither treatment provided a conclusive therapeutic effect [15]. The systemic administration of antimicrobial agents was tested in the treatment of peri-implantitis; however, the results were limited due to resistant strains of bacteria and ineffective drug dosages [16, 17].

Other recommendations included apically positioned flaps to establish adequate plaque control and polishing threads of implants, especially when wide bony defects are present [18, 19]. However, such therapeutic methods are associated with cosmetic deficiencies in the aesthetic zone. Citric acid and sandblasting [20], sandblasting alone [21–23] or chlorhexidine irrigation [24] has also been recommended. However, these were studies in animals or clinical case reports without long-term data.

There are experimental studies [5, 6] but only two clinical studies [19, 25] demonstrating the surgical treatment of peri-implant infrabony defects. Different therapeutic methods have been recommended to treat peri-implant lesions. Currently, there are no standard treatment protocols to control peri-implant infections, and, therefore, long-term results have to be critically assessed [26]. Lasers may reduce the bacteria and decontaminate the implant surface [27–31], and some articles presented positive effects of laser irradiation to control peri-implant infections.

Moreover, previous *in vitro* microbiological studies have shown a significant reduction in periodontopathogenic bacteria on implant surfaces when implants are irradiated with different high-intensity (surgical) lasers [30, 31] or low-intensity (soft) lasers using photosensitizers [32]. Even though the inclusion criteria for a review article should be precisely defined, and a meta-analysis or systematic review is necessary, there is no evidence-based therapeutic method today for the treatment of peri-implant defects [26]. Therefore, we also describe in this report a small number of cases, in order to include examples of the clinical application of lasers in implant dentistry.

The paper presents and discusses different techniques of laser usage in the soft tissues around implants and also methods for the treatment of peri-implantitis. A balanced evaluation of the different laser wavelengths and also the

advantages and disadvantages of their application in implant dentistry will be presented.

Laser application to soft tissue during implant surgery

Although therapy for peri-implant mucositis should be based on permanent and systematic plaque control to eliminate the aetiological factors of the disease, the treatment of peri-implant hyperplasias is the excision of the soft tissue around the implant [33].

The second-stage surgery of submerged implants and the surgical removal of hyperplastic peri-implant tissue can be performed with a scalpel, or by electrosurgery or laser [33]. With the scalpel for incision or excision, there may be some bleeding, pain and discomfort during and after surgery. Electrosurgery may damage the implant surface dramatically, disturbing osseointegration and leading to implant failure. Laser surgery is characterized by excellent coagulation, and pain relief for the patient [34].

The carbon dioxide (CO₂) laser has been used in the past for excision and vaporization of different soft tissue tumours and peri-implant hyperplasia [34]. The mode of application may be continuous or superpulse, which allows relatively fast excision, adequate coagulation and excellent patient comfort. Patients with implant-supported restorations are able to use their overdentures immediately after surgery, when these prostheses are soft (Fig. 1). Laser fibre systems [i.e., neodymium:yttrium–aluminum–garnet (Nd:YAG), diode lasers] must be used with special care, because of the higher penetration depth, and the possible damage to the bone in direct bone irradiation. Owing to the different interactions between the laser and implant surfaces and the higher absorption by titanium, such lasers may overheat and damage the implant surface.

However, Arnabat-Dominguez et al. [35] described second-stage surgery of submerged healed implants using the erbium:yttrium–aluminum–garnet (Er:YAG) laser with successful results, except on implants located where aesthetic considerations were important or in areas with insufficient width of keratinized mucosa surrounding the implants (Table 1).

Laser applications in peri-implantitis therapy

There is no doubt that, In the case of peri-implantitis, the implant surface is contaminated with soft tissue cells, bacteria and other bacterial by-products [36]. Micro-irregularities of the implant surface support bacterial adherence and, in cases of contamination, wound healing is compromised. Furthermore, endosseous implants with rough surfaces [sandblasted, titanium plasma sprayed (TPS)

Fig. 1 **a** Hyperplastic soft tissue around the implant immediately before CO₂ laser-assisted excision. **b** CO₂ laser-assisted excision of the hyperplastic peri-implant soft tissue. **c** Coagulation and sufficient carbonization of the peri-implant soft tissue during laser irradiation. **d** Final result 1 year after laser excision

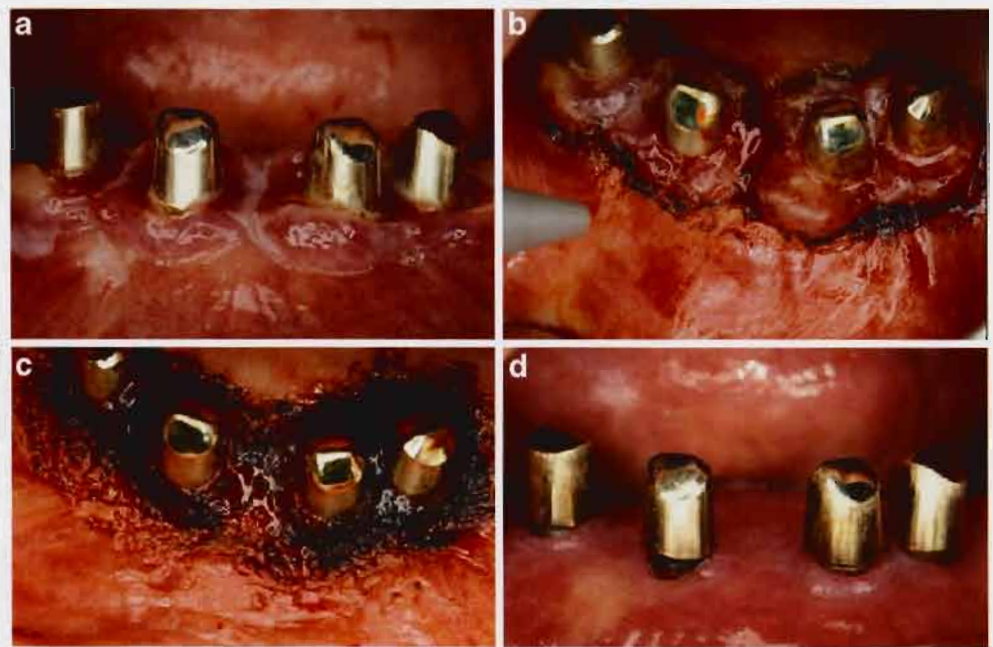


Table 1 Effects of lasers on implant surface (*Er,Cr:YSGG* erbium,chromium:yttrium–scandium–gallium–garnet)

Study	Laser wavelength	type of study	effects
Block et al. [27]	Nd:YAG	In vitro	Melting, sterilization
Kato et al. [28]	CO ₂	In vitro	Bacterial reduction
Bach et al. [29]	Diode (810 nm)	Clinical	Pocket reduction
Romanos et al. [30]	CO ₂	In vitro	Bacteria reduction
Kreisler et al. [31]	Diode (810 nm)	In vitro	Bacteria reduction
Haas et al. [32]	Photodynamic therapy	In vitro	Bacteria reduction
Amabat-Dominguez et al. [35]	Er:YAG	In vivo	Second-stage surgery
Romanos et al. [47]	Diode (980 nm)	In vitro	No surface modifications
Romanos et al. [47]	Nd:YAG	In vitro	Significant melting
Romanos et al. [48]	CO ₂	In vitro	No surface modifications
Deppe et al. [51]	CO ₂	In vitro	No surface modifications
Deppe et al. [56]	CO ₂	In vivo (dogs)	New bone formation
Oyster et al. [54]	CO ₂	In vitro	No significant temperature rise
Romanos and Nentwig [55]	CO ₂	Clinical	Peri-implantitis therapy
Deppe et al. [58]	CO ₂	clinical	Peri-implantitis therapy
el-Montaser et al. [69]	Er:YAG	In vivo	No thermal damage
Kesler et al. [73]	Er:YAG	In vivo	Better osseointegration
Sasaki et al. [75, 76]	Er:YAG	In vitro	Minimal surface changes
Lewandrowski et al. [77]	Er:YAG	In vivo	Better healing than the drill
Pourzarandian et al. [78]	Er:YAG	in vivo	Initial faster bone healing
Schwarz et al. [79]	Er:YAG	In vivo	Safe (but not better) healing when compared with the control
Romanos et al. [80]	CO ₂ , Er,Cr:YSGG	In vitro	Attachment of osteoblasts
Schwarz et al. [81]	Er:YAG	In vitro	Reduction in bleeding on probing
Takasaki et al. [82]	Er:YAG	In vivo	Re-osseointegration
Mouhyi et al. [84]	CO ₂	In vitro	No significant temperature rise
Rechman et al. [85]	Er:YAG	In vitro	Surface changes

and hydroxyapatite (HA)-coated] are characterized by better anchorage to the alveolar bone, but, when such implant surfaces are contaminated, it is very difficult to prevent the peri-implant inflammation.

Different modes of peri-implantitis therapy and implant decontamination have been reported [19–24]. Guided bone regeneration (GBR) techniques have been used for the treatment of bone defects around the implant [19, 25]. These are precise surgical techniques requiring excellent surgical skills. There can be complications, such as exposure of the non-resorbable (expanded polytetrafluoroethylene) membranes [24, 37], which requires the earliest possible removal of the membrane [37]. An increase of bone was reported in these studies, re-osseointegration around all types of implants was not ideal [24], and this procedure had limited predictability in daily practice [38–40]. In general, peri-implant bone defects are characterized by poor bone regenerative capacity adjacent to contaminated implant surfaces [37]. Currently, there are no clinical studies or case series documenting successful regenerative procedures in peri-implant bone lesions. Some case series demonstrated limited bone fill after GBR procedures [39]. To enhance results, reduce bone loss due to peri-implantitis, and to attain bone regeneration around implants, investigators suggested that it would be necessary to decontaminate ailing implant surfaces [11, 13, 39].

Several studies showed the dramatic changes that curettage and ultrasonic instrumentation can make on the implant surfaces [41–43]. The application of air–powder abrasive instruments also may affect the surface of HA-coated implants [44], and there is an enhanced risk of air emphysema when deep alveolar bony defects are treated [45, 46]. The removal of bacterial plaque and endotoxins by mechanical instrumentation is difficult, between the threads of the implant when the surfaces are rough, and bacteria and lipopolysaccharides can remain on the implant surfaces after mechanical antimicrobial therapy.

Various reports have shown some changes in the implants' surface textures as a function of the type of laser and wavelength that was used [33, 34, 47–51]. In addition, the lasers' characteristics are important, because of the different reactions they can produce on the implant surfaces (Table 1). Specifically, the physical properties of the CO₂ laser and the surgical effects of its wavelength allow soft tissue removal in areas around the implant, as well as decontamination of implant surfaces. Continuous wave CO₂ lasers do not appear to have adverse effects on the surface chemistry, but the superpulse mode seems to have a significant influence on the surface chemistry, which is not desirable for decontamination of failing implants [51]. A previous study reported that continuous wave (cw) CO₂ laser irradiation at up to 6.0 W power does not modify sandblasted, titanium plasma sprayed or HA-coated implant

surfaces [48]. Other authors recommend a 5.0 W power CO₂ laser to remove bacterial contaminants from the implant surfaces without any damage to the implant surface structure [28]. In contrast, Deppe et al. [51] showed that there was no implant alteration to the surface of TPS-coated implants, and excellent sterilization was demonstrated when the power setting was very low (2.5 W).

Romanos et al. [30] investigated the bactericidal effect of the continuous wave CO₂ laser (at a low power output of 2 W) on sandblasted titanium implant surfaces contaminated with *Porphyromonas gingivalis* and also showed a significant reduction in *P. gingivalis* after CO₂ laser irradiation of implant surfaces. This is comparable to the results of Coffelt et al. [52], who demonstrated an ablation threshold energy density of 11 J/cm² on root surfaces.

Kato and colleagues [28] showed that the CO₂ laser may have a significant bactericidal effect, reducing periodontopathogenic bacteria.

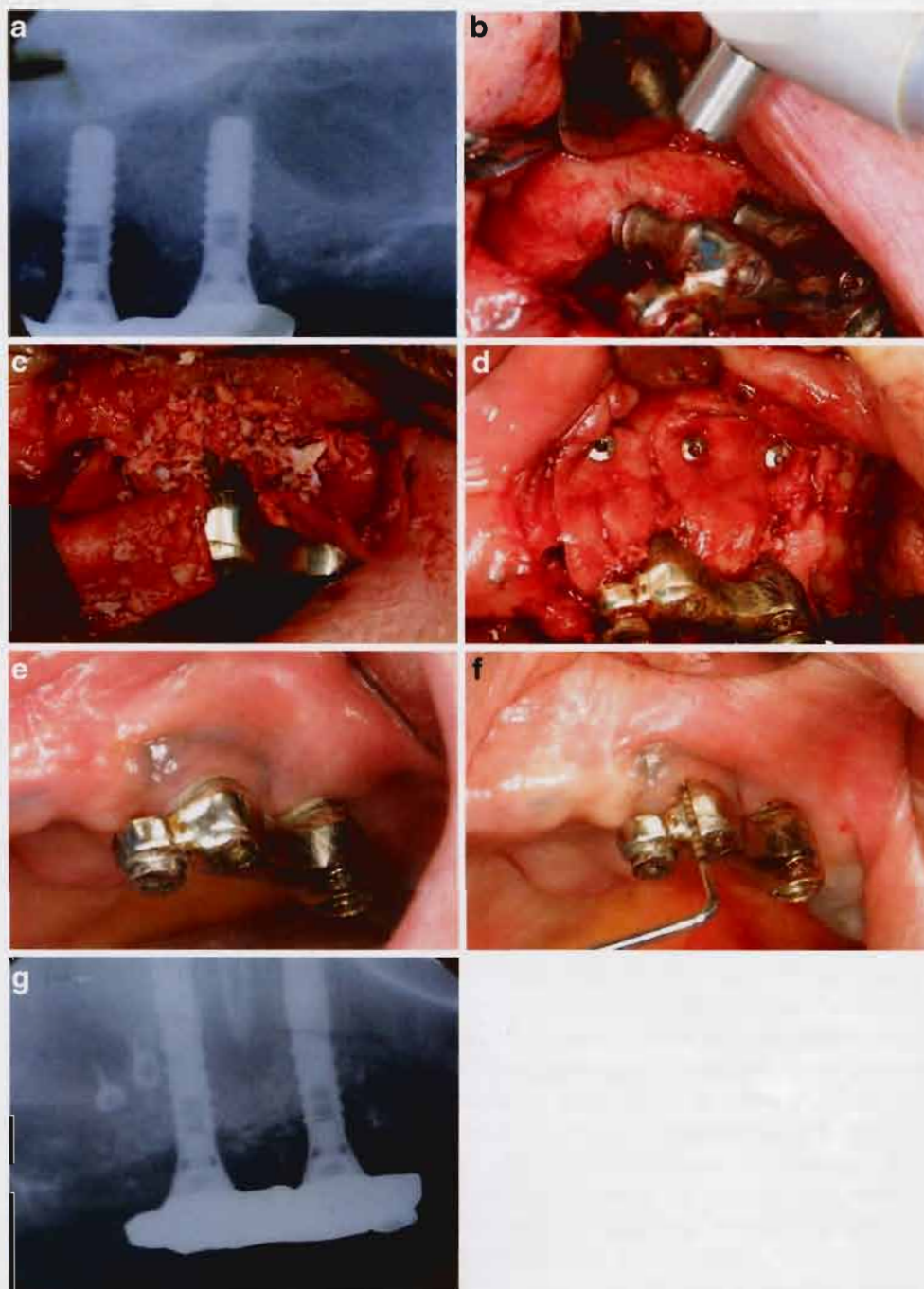
Encouraging results were reported when CO₂ laser was used as a decontamination device to improve re-osseointegration [51] in dogs. The study suggested that this laser system may be an effective therapeutic modality in the treatment of peri-implantitis.

Based on scanning electron microscopy (SEM) studies, many authors have demonstrated that the CO₂ laser does not change the implant surface or the type of implant surface pattern (sandblasted/HA-coated and TPS) [48–54]. It was also reported that the use of the low power CO₂ laser (2–4 W, cw or 6 W pulse mode at a frequency of 20 Hz and width of 10 ms) induced only a small temperature increase, but below the threshold levels [54].

In a clinical study Romanos and Nentwig [55] demonstrated the successful treatment of peri-implant defects using the CO₂ laser in combination with bone grafting with autogenous or xenogenic grafts. The augmented areas were covered with a resorbable barrier based on GBR principles. Follow-up examinations showed significant reduction in the pocket probing depth. No inflammatory reactions around the implant (e.g., bleeding or suppuration) were noted during the entire observation period. Complete bone fill was observed radiologically in all infrabony defects after the use of xenogenic materials in all sites treated with autogenous bone grafts, and at least two-thirds of the bony defect had filled with bone due to some bone graft resorption over time (Fig. 2). The authors attributed the bacterial reduction in the very deep bony lesions and the surrounding bone to the reflection and transmission of the laser light by the implant material during irradiation.

Histological observations in animal studies demonstrated significant new bone formation after CO₂ laser irradiation around implants with peri-implantitis-induced bone defects. The laser seemed to be able to decontaminate the implant surface and to re-osseointegrate ailing implants with TPS

Fig. 2 **a** Radiograph showing crestal bone loss around the two implants. **b** Implant decontamination with a defocused CO₂ laser immediately before augmentation. **c** Augmentation with bovine grafting material immediately after implant decontamination. **d** Coverage of the augmentation sites with a collagen membrane. **e** Clinical result 8 months after peri-implantitis therapy. **f** Clinical result 8 months after peri-implantitis therapy, showing the shallow peri-implant pockets. **g** Radiological examination 8 months after peri-implantitis therapy shows the new bone formation around the failing implants and the stable result



rough surfaces [56, 57]. Based on these experimental data Deppe et al. [58] demonstrated the clinical safety and efficacy of the CO₂ laser when applied with beta-TCP for the treatment of peri-implantitis.

The diode laser should be an alternative option to the CO₂ laser for decontamination of implant surfaces after flap elevation. Diode lasers are advantageous for the general practitioner because the units are small and reliable [59].

Significant antimicrobial effects were demonstrated in an in vitro study, in which peri-implant pockets were irrigated with toluidine blue and the peri-implant defects were

irradiated with a diode low-intensity laser (905 nm for 1 min) [32]. However, there were no histomorphometric data showing new bone formation and re-osseointegration after the use of this laser wavelength.

An in vitro study with different implant surfaces [47] has shown that 980 nm diode lasers using high-power settings (10 W) do not damage titanium surface texture. Further, clinical indications for diode laser can be the removal of peri-implant overgrowths as well as decontamination of implant surfaces before augmentative surgical procedures; however, the use of a diode laser with an 810 nm

wavelength in a high-power setting adversely changes the implant surface, and, for that reason, such lasers have to be applied with special care in order to treat peri-implantitis efficiently [29]. High-power diode lasers (810 nm) have excellent coagulation properties that are similar to those of the Nd:YAG laser [53, 60] and are characterized by the superficial tissue absorption with penetration to the underlying tissues [61, 62].

In contrast to the promising results of the CO₂ laser and diode lasers in studies investigating irradiation of implant surfaces, the application of a contact Nd:YAG laser leads to sufficient decontamination, in terms of sterilization of the implant, but also significant changes (melting and crater-like formation) of the implant surface [27, 48]. Furthermore, a significant temperature increase during laser irradiation has also been reported [63]. For these reasons the application of the contact Nd:YAG laser for the treatment of peri-implantitis, and for other soft tissue surgical procedures such as treatment of hyperplastic mucositis and second-stage surgery in submerged endosseous implants, is contraindicated.

Recent technological advances have led to an increase in the treatment options for dento-alveolar surgery. The traditional therapeutic techniques for bone removal using high-speed and low-speed rotary instruments, bone chisels and bone files were compared with the use of laser in bone surgery. Since there is no need to exert pressure on the bone, lasers may be superior to mechanical drilling [64, 65]. Several studies have demonstrated that the Er:YAG laser cuts bone precisely, with minimal thermal damage of 10–15 μm [63–67]. The laser removes a fixed amount of material per pulse, making precise control of cutting depth possible [68–72], and the low average power provides holes comparable to those obtained with mechanical drills. A previous study using a rabbit tibia model reported delayed healing of laser osteotomies compared with conventional saw osteotomies [64]. To date, few comparative studies of osseointegration of titanium implants in Er:YAG laser-prepared bone have been performed [69–73]. When lasers are used for bone surgery, careful histological and histomorphometric evaluation of bone and percentages of bone-to-implant contact after healing are required. Kesler et al. [73] compared the osseointegration of titanium alloy implants placed in the tibiae of rats, when bony cavities were created by Er:YAG laser and mechanical drill. Er:YAG laser was used with a regular non-contact handpiece, metal tip and water irrigation. The parameters used were 2 mm spot size on focus, 500–1,000 mJ per pulse, 400 ms pulse duration, and an energy density of 16–32 J/cm². The authors removed a bone volume of 1.4 mm³ per pulse. Based on the results of this study, it may be assumed that Er:YAG laser can definitively be used clinically for implant site preparation

with subsequent osseointegration and bone healing, with a statistically significant higher percentage of bone-to-implant-contact than with the conventional methods. In addition, collateral bone damage was less than in the bur-prepared bone. Perhaps because of the difficulty of applying sufficient coolant between the bone and the drill bit, the bur may cause necrosis, despite the use of low bur speed. By external irrigation of the bone with saline solution during the laser treatment, it was possible to reduce carbonization of the bone and enhance healing of the implant site. There is no doubt that laser irradiation should be avoided close to anatomical structures of importance, such as nerves, in order to avoid damage due to overheating. The Er:YAG laser allows the removal of the cortical part of the bone, penetrating to a depth of 3–4 mm, and insertion of the implant is possible, especially in weak bones. However, it is not possible at the moment to create the entire osteotomy in the total length and diameter with the Er:YAG laser or any other laser. In addition, it is not possible to have sufficient cooling during laser irradiation at the osteotomy site, and there is a need for further development.

The authors [73] concluded that the Er:YAG laser could promote the growth of new bone around titanium implants and better osseointegration than with the conventional osteotomies. The results of this study indicated that, in the rat model, the implant sites prepared by laser developed a statistically higher percentage of bone-to-implant contact than that at conventionally prepared sites.

Other studies have reported similar laser-induced stimulation of bone growth [74]. Sasaki et al. [75, 76] demonstrated that surfaces prepared by Er:YAG laser revealed only minimal changes without severe thermal damage, limited to a width of approximately 30 μm , microstructural changes of the original apatites, and reduction of the organic matrix. The typical irregular pattern of irradiated tissue consisted of biological apatites surrounded by organic matrix, and there were no toxic products on the Er:YAG-lased surfaces [75]. Lewandrowski and colleagues [77] also reported that the healing rate following Er:YAG laser irradiation may be equivalent to, or even faster than, that following bur drilling. In addition, the lack of a smear layer and the typical irregular pattern presented by the irradiated tissue may potentially enhance the adhesion of blood elements at the start of the healing process. A further advantage of the faster healing process and laser-induced bone growth may be the earlier function and loading of the implant.

Pourzarandian and co-workers [78] presented a histological and electron microscopy evaluation of bone formation, using the Er:YAG laser, the conventional bur, and the CO₂ laser, in the calvarial bone of rats. The initial healing following Er:YAG laser irradiation was faster. In contrast to

these studies, Schwarz et al. [79] observed safe healing after Er:YAG laser osteotomy, but the osseointegration of the implants was no better than that in the conventional osteotomy.

For new bone formation and re-osseointegration after treatment of peri-implantitis or in implant site preparation, osteoblast attachment to the titanium surfaces is necessary. Cell culture experiments have become more attractive in recent years in our attempts to understand, control, and direct interfacial interactions at biomaterial surfaces. In particular, cultures of osteoblasts, either primary or from tumour lines, are frequently used to evaluate the effects of surface modifications on cell behaviour and metabolism.

Using scanning electron microscopy, Romanos et al. [80] investigated the attachment of osteoblasts to the titanium surface after laser irradiation of the implant surface. They used four different types of autoclaved titanium disks with machined, HA-coated, sandblasted, or TPS surfaces. The disks were irradiated with a CO₂ laser (10,600 nm), with a power output varying between 4 W and 6 W and a frequency of 20 Hz, and an erbium:chromium:yttrium–scandium–gallium–garnet (Er,Cr:YSGG) laser (2,780 nm), with a power of 1.25 W after laser irradiation. All the implant surfaces examined were well colonized with osteoblasts. Cell morphology was similar for the irradiated titanium disks and the non-irradiated control group. Cell density in the irradiated test group was similar to that in the non-irradiated disks. The study data showed that laser irradiation of titanium surfaces did not negatively influence osteoblast attachment and cell proliferation. These findings may help to explain the effect of laser irradiation on implant surfaces and support the possibility of new bone formation after implant irradiation.

Recent results from a clinical pilot study have shown that non-surgical therapy using Er:YAG laser was able to reduce bleeding on probing significantly, from 83% at baseline to 31% after 6 months, but it did not significantly reduce the pocket depth and the clinical attachment levels between the laser and control groups [81]. Promising results in the treatment of peri-implantitis have been demonstrated histologically in a study by Takasaki et al. [82]. Experimentally induced peri-implant infections were treated with Er:YAG laser and compared with a curette group. The study showed that there were better results and a tendency to produce greater bone-to-implant contact (re-osseointegration) when the Er:YAG laser was used.

Conclusions

The increased annual placement of oral implants around the world is also associated with a higher number of complications, such as pathological reactions in the soft tissue

surrounding the implant and peri-implant bone defects with continuous loss of supporting bone. Bacterial contamination of implant surfaces is a common reason for implant failure. The modern concepts of clinical treatment for peri-implantitis are not well studied and sometimes do not lead to successful results.

Ideally, bone-to-implant contact should be increased histomorphometrically, and implants should become re-osseointegrated. At present, there is no evidence that anti-infective treatment of implant surfaces prolongs the longevity of an implant [26, 83].

In the past few years a wide spectrum of indications in modern implant dentistry has been proposed for laser systems. In general, lasers can be used in oral implantology for second-stage surgery of submerged implants, surgery to establish the health of soft tissue surrounding the implant, decontamination of titanium implant surfaces, and, experimentally, for implant site preparation. There is a potential interest in the clinical use of the 980 nm diode laser, which has excellent properties of incision, excision and coagulation of the soft tissues. Intraoperative and postoperative clinical findings were excellent, due to its sufficient cutting abilities, precise incision margin, good coagulation effect, and extremely small zone of thermal necrosis in surrounding tissues. [33]

According to recent literature (see Table 1) concerning the application of different laser wavelengths in the treatment of peri-implant lesions, the use of CO₂ laser (cw as well as pulsed mode) and diode laser (especially 980 nm) seems to be effective against bacteria without changing the implant surface pattern, as shown by scanning electron microscopy [47, 48]. It has also been noted that irradiation of the implant does not significantly increase the temperature of the implant body [28, 54, 63, 84]. In this respect, Kato et al. [28] noted a slight temperature increase, which did not negatively influence the attachment of fibroblasts or osteoblasts to the implant surface. With regard to the impact of the laser on the tissue surrounding the implant, there is decreased penetration depth due to absorption of the carbon dioxide radiation by the high water content of the mucosa. Both laser systems also showed excellent results in surgical procedures such as excision, incision and coagulation of soft tissues. Laser was advantageous in comparison with conventional methods, such as scalpel or electrosurgery, because of reduced pain and lack of haemorrhage. Furthermore, electrosurgery may damage the implant surface.

The Er:YAG laser also showed a bactericidal effect, which could be used for peri-implantitis therapy [50], although some authors observed modifications of the implant surface after irradiation [85]. Based on the findings in recent literature, the Er:YAG laser may be used clinically for implant site preparation with good results for osseointe-

gration and bone healing, and with a statistically significant higher percentage of bone-to-implant contact than that with conventional methods of site preparation.

The Nd:YAG laser produces sufficient decontamination in terms of sterilization of the implant surface. The application of Nd:YAG laser for treatment of peri-implantitis, hyperplastic mucositis and second-stage surgery of submerged implants is contraindicated, due to the significant increase in the temperature during laser irradiation, the extensive melting of the implant surface and the higher penetration depth of the laser beam.

Acknowledgements The authors would like to thank Michael Yunker, D.D.S, for his assistance in the preparation of the manuscript.

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